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Chemical Warfare in World War I: The American Experience, 1917-1918

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Fort Leavenworth, Kansas 66027-6900

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FOREWORD

This *Leavenworth Paper* chronicles the introduction of chemical agents in World War I, the U.S. Army's tentative preparations for gas warfare prior to and after American entry into the war, and the AEF experience with gas on the Western Front.

Chemical warfare affected tactics and almost changed the outcome of World War I. The overwhelming success of the first use of gas caught both sides by surprise. Fortunately, the pace of hostilities permitted the Allies to develop a suitable defense to German gas attacks and eventually to field a considerable offensive chemical capability. Nonetheless, from the introduction of chemical warfare in early 1915 until Armistice Day in November, 1918, the Allies were usually one step behind their German counterparts in the development of gas doctrine and the employment of gas tactics and procedures.

In his final report to Congress on World War I, General John J. Pershing expressed the sentiment of contemporary senior officers when he said, "Whether or not gas will be employed in future wars is a matter of conjecture, but the effect is so deadly to the unprepared that we can never afford to neglect the question." General Pershing was the last American field commander actually to confront chemical agents on the battlefield. Today, in light of a significant Soviet chemical threat and solid evidence of chemical warfare in Southeast and Southwest Asia, it is by no means certain he will retain that distinction.

Over 50 percent of the Total Army's Chemical Corps assets are located within the United States Army Reserve. This *Leavenworth Paper* was prepared by the USAR Staff Officer serving with the Combat Studies Institute, USACGSC, after a number of requests from USAR Chemical Corps officers for a historical study on the nature of chemical warfare in World War I. In fulfilling the needs of the USAR, this *Leavenworth Paper* also meets the needs of the Total Army in its preparations to fight, if necessary, on a battlefield where chemical agents might be employed.

CARL E. VUONO
Lieutenant General, USA
Commandant

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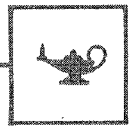

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Introduction

The combat experience of World War I provided the U.S. Army with its first significant exposure to chemical warfare. The purpose of this paper is to show how the Army prepared for this kind of warfare and how soldiers in the American Expeditionary Forces (AEF), from generals to doughboys, adapted or failed to adapt to fighting a war in which chemical weapons played a prominent role. Because no one AEF division experienced every facet of gas warfare, the study will examine information pertaining to many units in order to give a more complete picture of the phenomenon.

In World War I terms, chemical warfare included not only gas, but liquid flammable material, thermite, and smoke (all of which are relevant to the modern battlefield). This study will deal only with what participants referred to as "chemicals," "gases," or "war gases." These included real gases such as phosgene and chlorine, and also weapons that, while referred to as gases, were in fact vaporized liquids (mustard gas, for example) or finely ground solids. In this study the terms "chemical agent" and "gas" will be used interchangeably. Smoke will be discussed, but only as a *ruse de guerre* for gas; liquid flame and thermite will not be covered. Because most of the U.S. experience was on the Western Front, that theater of the war will receive detailed treatment.

Despite technological advances in chemical warfare since 1918, many lessons learned on the battlefields of World War I are valid for study today, if only because America's principal antagonist in world affairs, the Soviet Union, appears to be quite willing to employ chemical agents on today's battlefield. During the decade of the 1970s persistent accounts of the use of chemical agents by the Russians and their clients caused the U.S. government to pay closer attention to the problem of chemical warfare. Soviet offensive equipment captured by the Israelis in the 1973 October War contained filtration systems for survival on a chemical or biological battlefield. Reports from Laos about Vietnamese using a chemical agent called "Yellow Rain" on mountain tribesmen prompted a policy review by U.S. government officials. In December, 1979, the Soviet invasion of Afghanistan, with subsequent reports from Afghan refugees that the invaders were using gas during combat operations, again forced the U.S. Army to reassess its chemical warfare doctrine.[1]

U.S. intelligence estimates indicate that the Russians have between 70,000 and 100,000 chemical warfare troops. Every Soviet line regiment has a Chemical Defense Company. Present Soviet chemical delivery systems include artillery, mortars, multiple rocket launchers, bombs, air spray, and land mines. The blood, blister, and nerve agents in the Russian chemical arsenal include mustard gas (a blister agent) and phosgene (a lung injurant)—two of the most effective agents used in World War I.[2]

There is an abundance of material available for a study of gas warfare during World War I. Sources include unit reports, the published and unpublished diaries of participants, books written by chemical officers during the interwar period, and a number of secondary historical works of more recent origin. Also, I conducted several interviews with veterans of the First World War to obtain as accurate a picture as possible of what it was like for an AEF doughboy to train for, and to live, work, and fight in, a chemical environment. During the war the newly created Chemical Warfare Service (CWS)* did its best to record its activities and report on the use of chemicals. I relied extensively on these records.

A number of agencies provided a great deal of assistance to me in the preparation of this paper, and I would like to acknowledge the staffs of the following institutions: the Technical Library, Chemical Systems Laboratory, Edgewood Area, Aberdeen Proving Ground; U.S. Army Chemical Center and School, Fort McClellan, Alabama; National Archives, Washington, D.C.; Military History Institute, Carlisle Barracks, Pennsylvania; and Combined Arms Research Library, U.S. Army Command and General Staff College, Fort Leavenworth, Kansas. I especially want to thank members of the 1st Gas Regiment Association for graciously consenting to be interviewed, and Lt. Col. Charles M. Wurm, Chemical Corps, CACDA, Fort Leavenworth, for providing me with a great amount of technical information and advice.

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*The forerunner of the CWS was the Gas Service, set up under AEF General Order 31, 3 September 1917. On 11 May 1918, when the CWS was established as a branch of the National Army, the Gas Service became the Overseas Division, CWS.

The Introduction of Gas Warfare in World War I

1

Of all the weapons employed in World War I, none stimulated public revulsion more than poison gas. The abhorrence of chemical warfare lingered long after the Armistice of 11 November 1918. Gas victims continually reminded the general public of the effect of chemical weapons, as illustrated by the often repeated story of a veteran's coughing fit being explained by a tap on the chest and an apologetic, "Gas you know."

The employment of chemical agents in war, however, did not begin with World War I. The earliest recorded incident occurred in the fifth century B.C. during one of a series of wars between Athens and Sparta.*[1] Over the centuries that followed, combatants on several occasions engaged in rudimentary forms of chemical warfare on the battlefield. If by the end of the nineteenth century the use of poison gas was still by far the exception and not the rule in war, there were in all the great powers a number of men who foresaw its widespread use should a general conflagration engulf Europe.[2]

A concern with poison gas manifested itself at the Hague Conference of 1899. One of the agenda items dealt with prohibiting the use of shells filled with asphyxiating gas. The proposed ban** eventually passed with one dissenting vote, that of the American representative, Naval Capt. Alfred T. Mahan, who declared that "it was illogical and not demonstrably humane to be tender about asphyxiating men with gas, when all were prepared to admit that it was allowable to blow the bottom out of an ironclad at midnight, throwing four or five hundred men into the sea, to be choked by water, with scarcely the remotest chance of escape." Secretary of State John Hay, in his instructions to Mahan, argued that the inventiveness of Americans should not be restricted in the development of new weapons. For Hay it made no sense for the United States to deprive itself of the ability to use, at some later date, a weapon that might prove to be more humane and effective than anything then present in the American arsenal.[3]

*Spartan forces besieging an Athenian city placed a lighted mixture of wood, pitch, and sulfur under the walls. The Spartans hoped the fumes would incapacitate the Athenians so that they would not be able to resist the assault that followed.

**The declaration stated, "The Contracting Powers agree to abstain from the use of projectiles the sole object of which is the diffusion of asphyxiating or deleterious gasses."

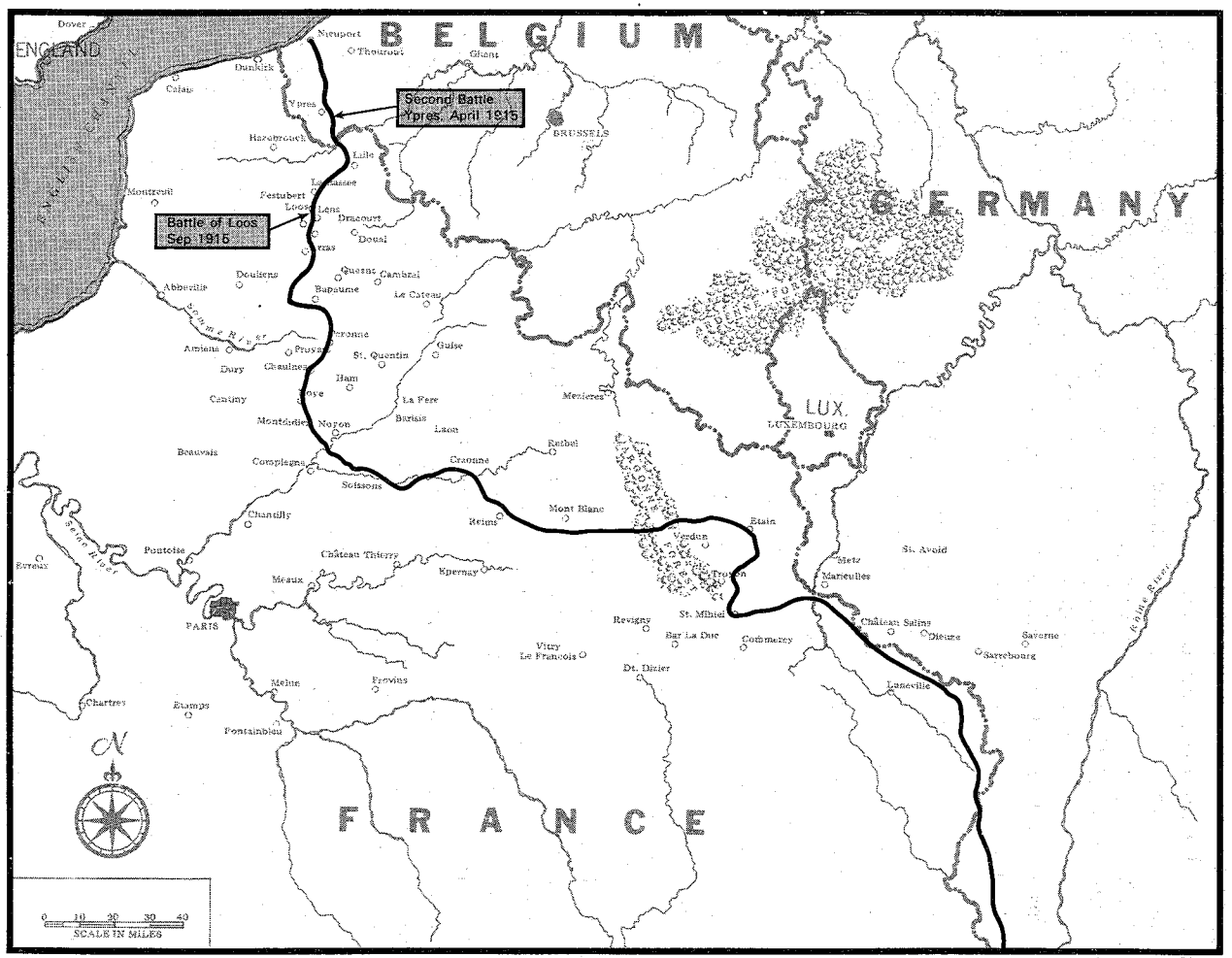
The Hague Conference declaration did not prevent some nations from discussing the use of chemical weapons, and at least one country, France, experimented publicly with gas. The French Army tested a grenade filled with ethyl bromoacetate, a nontoxic tear, or lachrymatory, agent developed for use in the suppression of small-arms fire from the concrete casements then prevalent in the permanent fortifications that dotted Western Europe. In 1912, French police used 26-mm grenades filled with this agent to capture a notorious gang of Parisian bank robbers. The Germans, unlike the French, did not experiment with chemical agents for military use as such, but at the outbreak of World War I, Germany's highly advanced dye industry gave it a sophisticated technological base from which to develop weapons of this nature.[4]

When war erupted in August, 1914, everyone from private citizens to the leaders of the belligerent countries shared a common belief that the economies of the European nations would neither survive nor support a lengthy war. As a result, the war plans of two key protagonists, Germany and France, called for a quick, decisive offensive against one another. Kaiser Wilhelm II of Germany assured his troops that they would be "home before the leaves fall." It was not to be. By the end of 1914, the armies on the Western Front were locked in a deadly form of trench warfare (Map 1),* sustained by the very industrialized economies that, because of their complexity and interdependency, had been thought unable to withstand a long war.[5]

Unwilling to accept the indecisiveness of trench warfare, army staffs on both sides pondered ways to break the deadlock and return to open or maneuver warfare. Alternatives were proposed, some strategic, others tactical. The British, for example, sought a strategic solution by a seaborne assault against Turkey, an ally of Germany. This attack at Gallipoli in 1915 sought to open the Dardanelles as the first step toward linking up with Russia and forcing Turkey out of the war. For a variety of reasons, the plan failed, and the deadlock on the Western Front continued.

As their attack at Gallipoli tottered to defeat, the British looked to the application of tactical innovation at Neuve-Chapelle to break the stalemate. On 10 March 1915 British artillery, instead of firing a lengthy bombardment prior to an attack, as doctrine dictated, let loose a brief but intense barrage on a relatively narrow German trench frontage. The fire was then shifted to the German rear in order to create a lethal steel curtain that would block reinforcements. To the surprise of everyone, the British infantry quickly

*One of the misconceptions surrounding World War I is that there existed a continuous, parallel belt of trenches stretching from the English Channel in the north to the Swiss border in the south. In fact, in some sectors along the 470-mile Western Front, soldiers occupied shell holes; in other areas, the terrain caused troops to be dispersed in fortified garrisons or strong points. Some trenches, as in the British sector of Flanders, were actually sandbagged parapets rising from marshy lands, where digging any deeper than a foot or two would have brought water to the surface. There was one factor, however, that was constant along the entire front. Whether in trenches, shell holes, or strong points, daily life offered little more than dull routine and boredom for the men of both sides as they waited for their respective high commands to decide their fate.



Map 1. The stabilized Western Front, 1915.

overran the German forward positions. The attack failed, though, primarily because the high command, viewing it as an experiment, did not have sufficient reserves available to exploit a breakthrough.

Germany also searched for ways to break the deadlock and decided on a solution involving gas. Early in the war the Germans kept a wary eye out for indications that the French were using their 26-mm gas grenades. Apparently, in August, 1914, France did use this chemical weapon, but in open areas where the gas quickly dispersed with no noticeable effect on the enemy. The French soon discarded the grenades as worthless. At this same time, stories were appearing in Allied newspapers about a new French liquid explosive, turpinite. While claiming that this substance gave off lethal fumes, the articles failed to explain that the gas reached a deadly concentration only in confined spaces. Still, the Germans were apprehensive and became alarmed by the deaths of a number of soldiers asphyxiated during a French bombardment, even though a medical team rushed to the scene concluded that the men died not from poison gas, but from inhaling carbon monoxide fumes while huddled in their dugout.[6]

In any event such newspaper stories and front-line experiences may have spurred the development of war gases by German scientists. Contributing to that effort, chemistry professor Walter Nernst suggested partially replacing the TNT in a 105-mm shrapnel shell with dianisidine chlorosulphonate, an agent known to cause irritation of the mucous membrane. The new filling would serve two purposes: it would conserve TNT and act as a chemical weapon. The German High Command accepted this new weapon, although it is uncertain which of the two purposes it initially considered more important. On 27 October 1914, 3,000 of these shells fell on British troops near Neuve-Chapelle. The soldiers suffered no ill effects and never suspected they were under chemical attack. The Germans continued to experiment with gas because they were convinced the idea had merit and because intelligence sources could not determine what effect the shells had had at Neuve-Chapelle. This lack of information on the effects of gas attacks was a common occurrence throughout the war.[7]

The Neuve-Chapelle experiment increased the German High Command's interest in gas warfare. The German General Staff asked the Kaiser Wilhelm Institute for Physical Chemistry and Electrochemistry in Berlin to investigate the possibility of using a more effective agent. The only guideline provided by the military was that the Hague declaration of 1899, banning projectiles used exclusively for delivering poison gases, had to be circumvented. Adhering to the letter if not the spirit of the ban, the Germans devised a gas shell that also contained an explosive charge for producing a shrapnel effect. The Professor von Tappan who designed the shell also solved two technical problems related to emplacing chemicals in an artillery projectile. First, he stabilized the liquid within a shell casing in order to reduce its tumbling in flight, thereby increasing the shell's accuracy and range. Second, to ensure that two extremely reactive chemical substances did not accidently combine in the shell casing, von Tappan developed a special shell, designated the T-shell by the German Army in his honor. The T-shell was a standard

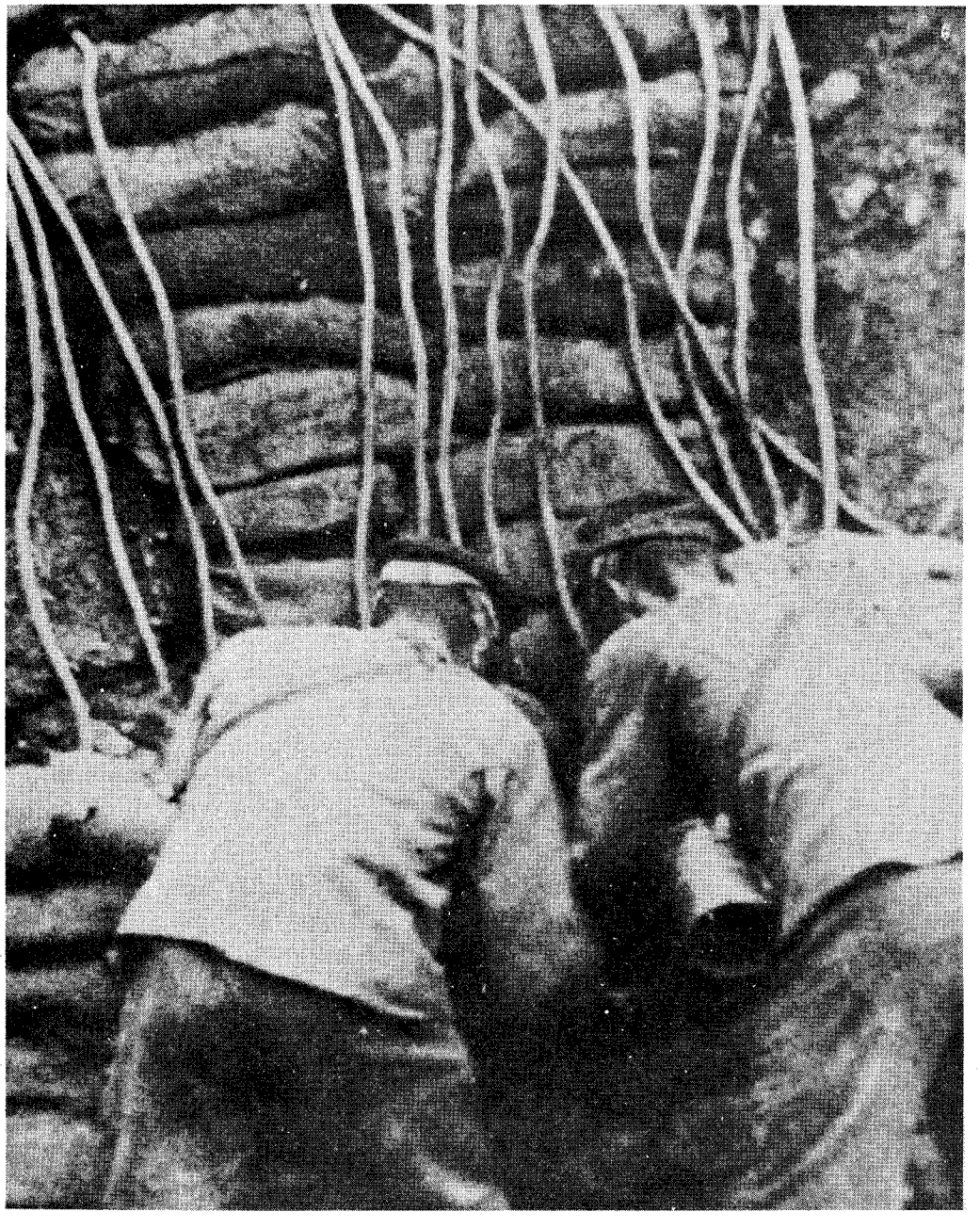
15-cm howitzer round that contained seven pounds of xylyl bromide and a burster charge for a splinter effect. A lead lining prevented contact between the burster charge and the chemical payload.[8]

The German High Command decided to use the first T-shells on the Eastern Front. On 31 January 1915, over 18,000 shells were fired at Russian positions at Bolimov. German officers, confident that their new weapon would neutralize the enemy positions, were surprised when their attack was repulsed with severe casualties. The shelling had had little or no effect on the Russians because cold temperatures had prevented vaporization of the xylyl bromide.[9]

To find a more effective means of employing gas on the battlefield, the German High Command turned to an assistant of von Tappan, Professor Fritz Haber. Haber, a reservist, had shown marked enthusiasm for the potential value of chemicals as weapons. Believing that T-shells did not provide a high enough concentration of chemicals to produce enemy casualties, he suggested the use of large commercial gas cylinders as a delivery system. Cylinders could deliver large amounts of gas and, like the T-shell, did not technically violate the Hague ban on projectiles. Haber also recommended the use of chlorine as an agent because it was commercially produced and readily available in large quantities. Chlorine also satisfied the requirements for military application: it was lethal, immediately effective, nonpersistent, and volatile. It was also dense enough to resist dilution in a moderate wind.[10]

Haber's gas cylinder project received the approval of the Chief of the German General Staff, General Erich von Falkenhayn, who had the professor appointed Head of the Chemical Warfare Department in the Prussian Ministry of War. The high command selected the front of the Fourth Army facing the French salient at Ypres as the location for an experimental attack. Pioneer Regiment 35 was designated to conduct the gas attack. Haber, assigned as a "chemico-technical advisor," assisted Colonel Peterson, the regimental commander, and instructed the troops on the emplacement and use of gas cylinders. By 10 March 1915 the Regiment, with the assistance of infantry labor, had emplaced 1,600 large and 4,130 small cylinders containing a total of 168 tons of chlorine. Then, for one month, the Pioneer troops sat and waited for the winds to shift westerly toward the enemy trenches in the Ypres salient. Only then could they safely unleash the chemicals by opening the cylinder valves.[11]

Late in the afternoon of 22 April 1915, a setting sun cast long shadows over the battle-scarred terrain around the medieval Belgium city of Ypres. In the distance the faint sound of large-caliber guns could be heard. Birds fluttered and swooped, seeking places to roost on the practically treeless landscape. Suddenly, at 1724, three flares rose from an observation balloon over the German lines and burst against the darkening eastern sky. German artillery commenced a fierce bombardment that landed to the rear of the French and British lines in the Ypres sector. Then, at 1800, an eerie silence fell over the area.



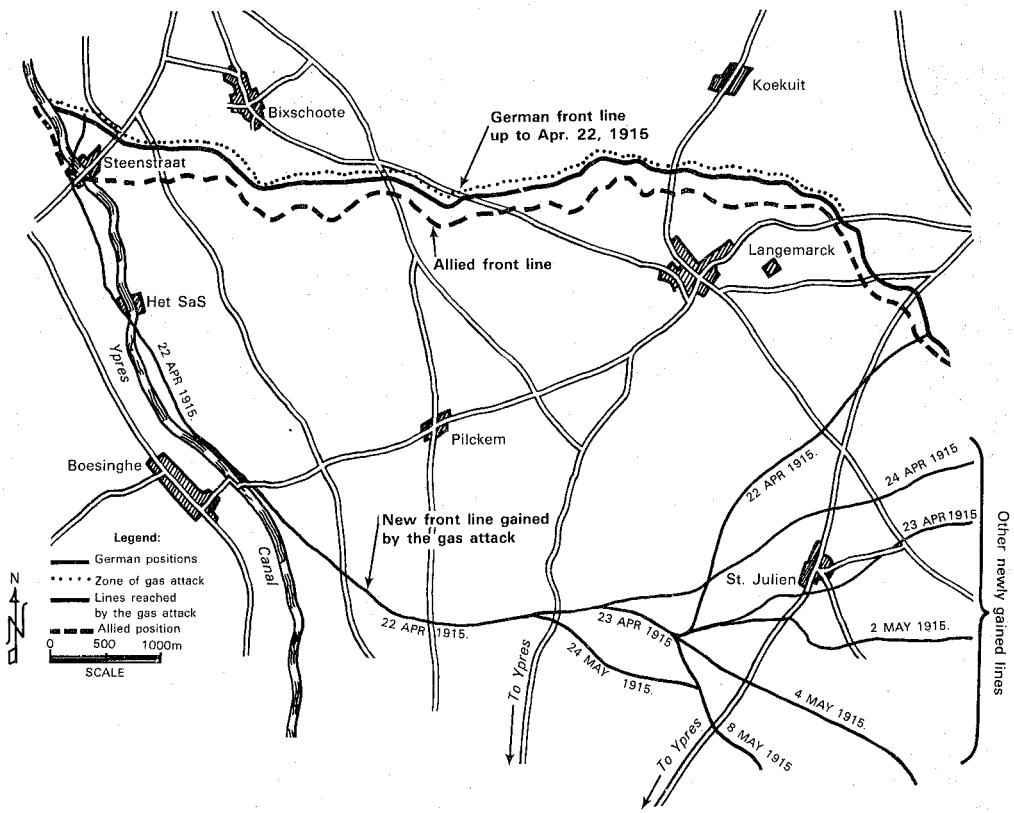
German Pioneer troops opening cylinders for a gas attack, 1916.

Peering across the battlefield, men of two French divisions, the 87th Territorial and the 45th Algerian, saw blue-white wisps of haze rising from the German trenches. The haze swirled about, gathered in a cloud that slowly turned yellow-green, and began to drift across the terrain at a height of up to six feet. As the cloud drifted, it settled into every depression in the landscape. Finally, the gentle north-northeasterly wind brought it spilling

into the French trenches, silently enveloping the occupants in a misty, deadly embrace.

To the north and southwest of the now mist-enshrouded French positions, British and Canadian troops looked into the haze and, to their amazement, saw soldiers, many without weapons, emerge from the cloud, "running wildly and in confusion" toward positions to the rear. Terror-stricken Algerians ran by the startled Dominion troops, coughing and clutching their throats. Moments later French soldiers staggered by, "blinded, coughing, chests heaving, faces an ugly purple color, lips speechless with agony." One by one, the guns of the French artillery batteries in the sector stopped firing, and the two French divisions collapsed. The Ypres front now had a gap over four-miles wide containing hundreds of men in a "comatose or dying condition." After half an hour, German troops, equipped with cotton wadding tied over their faces—a primitive form of protective mask—cautiously advanced into the breech created by the discharge of chlorine gas.

Following the initial shock and surprise, Allied commanders began to bring forward reserve troops and to move units from the left and right flank into the gap. The Germans advanced four and one-half miles until they encountered the ragged edge of a hurriedly organized defensive line (Map 2). The First Canadian Division and assorted French troops manned



Map 2. Ypres sector in Belgium, 22 April—24 May 1915.

the line in scattered, hastily prepared positions 1,000 to 3,000 yards apart. This improvised defense, together with the fact that the Germans had lost some of their combat edge during the month-long wait for favorable winds, finally slowed and then halted the attack. As for the German troops who reached their initial objective, they had only the most primitive protective equipment. When they saw the havoc their own gas had wrought, they had no wish to proceed any farther that night.

Two days later, during which time the British and French brought reinforcements into the area, the Germans discharged more gas. Although they did so again four more times throughout May, the element of surprise had been lost. The British and French troops were now equipped with their own primitive masks, and although the defenders suffered severe losses (over 5,900 casualties—nearly double the number of casualties for the attackers), the Germans could gain no more than a few hundred yards beyond the forward limit of their first attack. The German High Command, surprised as its opponents at the success of the new weapon, had no reserves to exploit a possible success. Thus, one of the war's greatest tactical surprises was dissipated on what amounted to an experimental attack with limited objectives.[12]

German medics, wearing an early mask, giving oxygen to gas victim, 1915. British, French, and Russian prototype masks were similar in design.

With the battle front at Ypres now stabilized, the British and French had to decide whether or not to retaliate in kind. Faced with the Germans' obvious technological advantage, the Allies at first hesitated to retaliate for fear of inviting the expansion of gas warfare. But when the British Expeditionary Force commander reported that a lack of an offensive gas capability would seriously impair the morale of his troops, the British cabinet gave its approval to use chemical agents. The French government soon followed suit for basically the same reason.[13]

On 24 September 1915, at 0550 near Loos, Belgium, the British launched the Allies' first attack supported by gas. It had taken them five frantic months to reach a point at which a large-scale gas attack was feasible. During that period, several "Special Companies" of Royal Engineers had been trained in the emplacement and discharge of gas cylinders. Unlike the Germans, the British decided to conduct their gas attack on a wide frontage. This necessitated the deployment of the cylinders clustered in batteries along the front rather than spaced far apart in one continuous line. To accomplish this, the British constructed galleries in front of the first-line trenches and positioned in them 5,500 cylinders containing 150 tons of chlorine.* The frontage was too wide to saturate all of it with gas, so the British decided to utilize smoke candles to simulate gas in those areas where the agent could not be used. By alternating the discharges of gas and smoke, the gas attack could be prolonged over forty minutes. This planned smoke screen was the first used during the war.

Fortune did not favor this first British gas attack. During the evening prior to the attack, the winds died. The following morning the British commander, Gen. Sir Douglas Haig, made a controversial decision to proceed with the attack despite uncertainty as to whether or not the slight breeze that rose in the morning would continue to blow toward the German lines. On the right flank, the gentle winds brought the gas and smoke mixture into the German trench system. There, the mild wind worked to the British advantage, for the cloud lingered and did not dissipate. On the left flank, however, not only did the winds fail, but in several positions the gas wafted back into the British trenches, engulfing the troops waiting to attack.

The Germans were taken by surprise. Their troops had little awareness of the danger posed by gas and were not sufficiently trained in defensive measures. The war diary of the German Sixth Army, the unit that bore the brunt of the attack, described the results. The gas in some instances caused little but momentary confusion, while in other cases entire units lost their ability to resist the follow-up British infantry attack. The German mask, which was essentially the same one used at Ypres, broke down as the gas lingered. The chlorine also caused rifles, machine guns, and even artillery breechblocks to jam. The most effective result of the gas was that it rendered German officers and noncommissioned officers (NCOs) incapable of shouting commands loud enough to be heard through their masks. The dense clouds

*This forward placement was made to protect the cylinders from German artillery, which was zeroed in on the first line of trenches to the rear of the galleries.

of smoke and gas also shrouded positions and precluded officers and NCOs from leading by example.[14]

In spite of some British gains, the attack fell short of the desired results for three reasons. The first was the decision to proceed with the attack despite the unfavorable wind conditions. Second, the British artillery was hampered in providing support because it lacked sufficient shells. Third, there were no reserve divisions to exploit a breakthrough. In his report, the British Commander-in-Chief, Sir John French, acknowledged that, although the attack failed to penetrate the German lines, the "gas attack met with marked success, and produced a demoralizing effect in some of its opposing units." More important, the major belligerents had accepted and expanded the use of chemicals as weapons of war.[15]

The ensuing chemical war proved to be one of experimentation with gases and with defensive and offensive equipment. As tactical doctrine and training evolved to reflect technological changes, the availability of gases and the imagination of commanders became the only limits to the employment of this new weapon.